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## THE EOLITHIC PROBLEM — EVIDENCES OF A RUDE INDUSTRY ANTEDATING THE PALEOLITHIC

BY GEORGE GRANT MACCURDY

### INTRODUCTION

Nature's processes may be likened to photography. She furnishes the sensitized film, and the finger of Time manipulates the camera. It remains for man to develop and interpret the exposures. The geological record is a film cartridge exposed and sealed again, bound up with which are the beginnings of man's own record on the earth. The process of development begins with the most recent exposure and works backward.

For a long time we had a picture of man's neolithic record only. In the early part of the last century, Boucher de Perthes, with the help of Sir Joseph Prestwich and others, clipped off another section of the film, which when developed revealed the long chapter of our paleolithic history. It took a good while for some of us to accept the interpretation put upon that picture. When finally and generally accepted, there was in many quarters a feeling of relief that we had at last reached the end, or rather the beginning, of the series of Father Time's snapshots at our primitive ancestors. Nevertheless, to some persistent investigators it seemed worth while to take another pull at this enigmatical film. They appear to have been rewarded by a bona fide negative; but, to say the least, there is a certain superficial indistinctness about it that has rendered the print rather unsatisfactory to some minds. Recently the negative has been so strengthened that we are now practically assured of a picture worthy of a frame, and a place on the walls of our prehistoric gallery.

In the order, then, of their taking, these three views may be labeled: (1) Eolithic, (2) Paleolithic, and (3) Neolithic. Sir John Lubbock, now Lord Avebury, furnished the names for the second and third. The first was christened as late as 1892 by another Englishman, Mr J. Allen Brown,<sup>1</sup> fellow of the Geological Society, and an enthusiastic student of the prehistoric. Two years later de Mortillet made use of the term "eolithic" for the first time by him, in his *Classification palethnologique*,<sup>2</sup> but did not refer to J. Allen Brown's article. The latter, in discussing the rude specimens found on the North Downs by Mr Benjamin Harrison, suggested that the term "eolithic" be applied to the "roughly hewn pebbles and nodules and naturally broken stones showing work, with thick, ochreous patina, found on the plateaux of chalk and other districts in beds unconnected with the present valley drainage." The de Mortillet classification was republished in 1900.<sup>3</sup> Leaving the paleolithic to represent the early Quaternary, he applied the term eolithic to all that has to do with the Tertiary. Dr Rutot of Brussels, to whom we are indebted more than to any one else for our knowledge of the eolithic period, and whose work will be discussed at length in this paper, does not limit it chronologically to the Tertiary. In his classification,<sup>4</sup> the early phases of the Quaternary, those connected with the first grand extension of the glaciers, are also eolithic, the well-known hache type (Chellean) of implement not appearing until the second advance of the ice.

When Thomsen published his relative chronology for prehistoric times in 1836, the only stone age known was that which is now called the neolithic period. Boucher de Perthes's first discovery of paleoliths came just two years later; but they were not accepted until after (Sir) Joseph Prestwich's visit to Abbeville in 1859. Eoliths have had a still longer and harder struggle for recognition. When first reported in 1867, they at once attracted considerable attention. After a lively discussion that lasted for

<sup>1</sup> On the continuity of the paleolithic and neolithic periods; *Jour. Anthr. Inst.*, March 8, 1892; XXII, pp. 93-94. Brown died Sept. 24, 1903.

<sup>2</sup> *Bull. Soc. d'anthr. de Paris*, 1894, p. 616.

<sup>3</sup> *Le préhistorique*, 3<sup>e</sup> éd.

<sup>4</sup> L'état actuel de la question de l'antiquité de l'homme; *Bull. Soc. belge de géol., de paléon. et d'hydrol.*, Bruxelles, 1903, XVII, p. 425.

five or six years, the subject was relegated to the background. It might have passed into oblivion had it not been for the researches of Sir Joseph Prestwich in England, begun about fifteen years ago, and for the more recent work of Rutot in Belgium. Some of the details in its eventful history are worthy of record here.

#### EARLY DISCOVERIES

The discovery in Pliocene deposits of incised bones first served to awaken an interest in the question of Tertiary man, and led more or less directly to the later discovery of flints thought to have been chipped intentionally. In fact, Sir Charles Lyell would not formulate an opinion as to the nature of the incisions on bone found by Desnoyers<sup>1</sup> in the sand and gravel-pit of Saint-Prest, near Chartres, because the deposits had yielded no stone implements. But not long after (1867), the Abbé Bourgeois found in the same deposits what he considered to be stone implements. These were obtained at various depths in the high-level gravels (Pliocene) at Saint-Prest and did not include the amygdaloid (Chellean) type generally supposed at that time to represent the earliest industry in stone. The associated fauna consisted of: *Elephas meridionalis*, *Rhinoceros etruscus* (Falconer), *Hippopotamus major* (?), *Equus arnensis*, *Trogotherium cuvieri*, three species of *Cervus* and one of *Bos*.

The Abbé Bourgeois's researches were soon extended to the Miocene at Thenay, and formed the subject of important communications to the International Anthropological Congresses of 1867 and 1872. At the latter, held in Brussels, a committee of fifteen was appointed to report on the chipped flints from Thenay, submitted by Bourgeois. Nine of the Committee — de Quatrefages, d'Omalius, Cartailhac, Capellini, Worsaae, Valdémair Schmidt, de Vibraye, Franks, and Engelhardt — pronounced in favor of certain specimens; five — Steenstrup, Virchow, Neyrinckx, Fraas, and Desor — found no evidence of intentional shaping; and one — Van Beneden — was unable to decide. De Mortillet remained to the last a champion of the Thenay specimens, some of which are preserved in the Musée des Antiquités Nationales at Saint-Germain. On the

<sup>1</sup> Note sur des indices matériels de la coexistence de l'homme avec l'*Elephas meridionalis*, etc.; *C.-R. Acad. des sciences*, Paris, 1863, p. 1073.

other hand, researches made by Professors Capitan and Mahoudeau in 1901 have led them to combat the existence of artifacts in the deposit at Thenay. Rutot withholds judgment until further evidence is forthcoming. At the Brussels Congress (1872), Carlos Ribeiro presented a paper on chipped flints from the Upper Miocene and the Pliocene deposits near Lisbon, Portugal. Later, one of his compatriots, Delgado, discovered similar specimens in the Upper Miocene at Otta. But the consensus of opinion is that the pieces from the valley of the Tagus and from Otta are not artifacts.

A better fate has been reserved for the discovery by J. B. Rames, in 1877, of chipped flints in the Tertiary at Puy-Courny<sup>1</sup> near Aurillac (Cantal). The beds resting on Miocene basalt are alluvial, and belong to the Upper Miocene. They contain the following fossils, as determined by Gaudry: *Dinotherium giganteum*, *Mastodon (angustidens or longi-nostris)*, *Rhinoceros schleiermacheri*, *Hipparion gracile*, *Tragoceros*, and *Gazella deperdita*. All the flints possess a brilliant black or dark yellow patina. The retouches and marks of utilization are most convincing. After a careful study of the pieces, de Mortillet, Cartailhac, Chantre, and Capellini declared that if these flints had been found in Quaternary deposits, no one would hesitate to regard them as having been chipped intentionally. De Quatrefages was of the same opinion, fresh confirmation of which is being received through the recent researches of Capitan, Rutot, Courty, and others. Until the question of the Thenay specimens is settled, those from Puy-Courny may be regarded as the oldest known artifacts, geologists being agreed as to the age (Upper Miocene) of the deposit, and archaeologists as to the genuineness of the industry.

#### THE CHALK PLATEAU

A tradesman of Ightham, Kent, Mr Benjamin Harrison, an enthusiastic naturalist who had been collecting paleoliths from the River drift of the neighborhood for years, extended his field of search in 1885 to include the summit of that portion of the Chalk plateau which lies between the valley of the Darent on the west and

<sup>1</sup> Two other stations in the neighborhood of Puy-Courny, but of less importance, are Belbex and Puy-Boudieu.

that of the Medway on the east. Here, at heights of from 400 to 600 feet above the sea, he discovered flints supposed to have been fashioned by the hand of man.

In the next six years Harrison brought together a collection numbering more than 1,000 specimens. In the meantime (1888) his researches attracted the attention of Sir Joseph Prestwich, whose country-seat was at Shoreham in the Darent valley near by. Thirty years earlier, Prestwich had confirmed the accuracy of Boucher de Perthes's discoveries in the valley of the Somme. He had now found a second Boucher de Perthes nearer home. Harrison's discoveries, however, did not have to do with paleoliths, but with the industry of a much earlier date. Here the geological conditions are entirely different. Harrison left the paleoliths and the Quaternary behind when he ascended to the North Downs. The specimens he found there are uniformly and deeply stained to a warm, ochrous brown color, precisely as are the natural flint fragments associated with them, the coloring matter being the red clay in which they are imbedded, and which is found in patches capping the summits of the Chalk plateau. Associated with this red clay is a southern drift, carried there from the still higher elevations to the south, at a time when the chalk bridged the present fertile valleys of the Weald (woodland), connecting the North Downs of Kent with the South Downs of Sussex.

According to Prof. Rupert Jones, the implements are always accompanied with chert and ragstone from the outcrop of Lower Greensand on the side of the old Wealden range that once rose 2,000 to 3,000 feet over what are now Crowborough and other Sussex hills. The red clay with flints, that stained the implements, is, on the contrary, of local origin and occurs over other areas as well as those reached by the southern drift containing the rude implements.

The southern drift on the summit of the plateau is older, then, than the great chalk escarpment or the valleys of the Darent and Medway, which drain the Wealden district and, on their way northward to the Thames, cut the Chalk plateau into three sections. The escarpment and the broad valleys of the present drainage system are older than the gravel terraces occurring at various

levels in the valleys. But, according to Prestwich, all these terraces up to a height of about 340 feet above sea-level are of post-glacial age and contain flint implements of the paleolithic type. The paleoliths associated with bones of the Mammoth and woolly rhinoceros found in the gravel-pits at Aylesford,<sup>1</sup> only a few feet above the present bed of the Medway, are later than those found in the high-level valley terraces; these in turn are subsequent to the great denudation that swept away the chalk bridge spanning the Weald and uniting the North and South Downs; and finally, from the very nature of things, this enormous denudation must have taken place subsequent to the time when the southern drift was carried northward and deposited with the red clay on the summit of the North Downs, where patches of it still exist.

Other evidence conclusive of the great antiquity of the plateau drift, as well as of the successive river drifts of the Thames valley, may be furnished by a section (figure 15) extending from the Lower Greensand hills, near Ightham, northward to the Thames at Milton Street. Such a section would pass through the summit level of Swanscombe hill, capped by Tertiary strata and forming an outlier of the older drift. This hill with its spread of southern drift, though not much more than 300 feet high, corresponds with the gradient of the plateau if extended southward and upward till it reaches West Yoke and Ash, where Harrison found some of his first specimens. At Milton Street, north of Swanscombe hill, and near the village of Swanscombe, the high-level river drift is met with at an elevation 200 feet lower than the plateau drift on the summit of Swanscombe hill. The Milton Street river drift is 100 feet above the Thames, and contains flint implements of the well-known amygdaloid (Chellean) type; while at a still lower level are brick-earths and gravel in which, associated with Quaternary mammalian remains, are found flint implements of a type later than those at Milton Street. Hence, there are at least three distinct and successive steps from Ash down to the Thames: plateau drift with eoliths, high-level river drift with paleoliths, and low-level river drift with paleoliths of a more perfected type. These epochs do not include

<sup>1</sup> I found remains of both Mammoth and Rhinoceros in the pits at Aylesford. I also obtained from one of the workmen a flint implement of the Acheulian type.

the neolithic culture of the region, evidence of which may be found on the surface at all levels.

The section described does not cut the Chalk plateau through its highest elevation, which, at Titsey hill, west of the Darent valley, is 864 feet above the sea. Even here, De Barri Crawshay found a patch of red clay and southern drift, with implements of the plateau type. This drift was transported across the chalk escarpment and the chalk plain into the Thames valley along lines independent of the present drainage; the patches that now cap the highest points marking what were then the valleys.

Prestwich thinks the southern drift may be of later date than the locally derived red clay with which it is so intimately associated. Both are older than the northern drift or boulder-clay and newer than the outcrop of Tertiary strata that caps the chalk at Swanscombe hill. Prestwich calls them simply pre-glacial, Rutot places them in the Middle Pliocene. The geological age of the plateau drift could be determined still more definitely were it not for two missing links in the chain of evidence. In the first place, the Tertiary series of deposits are not all present. The second difficulty arises from the absence of organic remains, the property of the infiltrating waters being such as to dissolve all calcareous elements as completely as if they were lumps of sugar. As soon, however, as the high-level river terraces are reached, the older type of paleoliths are found in association with a fauna in part now extinct.

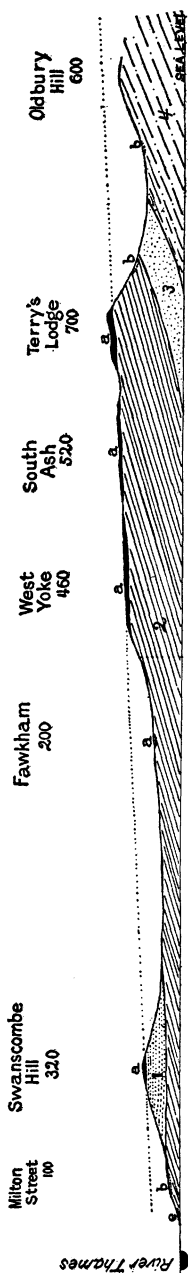


FIG. 15. — Section from the Thames to Oldbury Hill near Ightham, Kent (after Prestwich). 1, Tertiary. 2, Chalk. 3, Upper Greensand and Gault. 4, Lower Greensand. a, Red clay with flints — eoliths. b, Upper valley-gravel — paleoliths. c, Low-level valley-gravels — paleoliths.

The Shelly gravel-pit at Swanscombe is a good example. I am indebted to Mrs Stopes, wife of the late Henry Stopes, for some excellent examples of early paleoliths from this pit which has furnished remains of *Elephas antiquus*, *Elephas primigenius*, *Corbicula fluminalis*, and many other species, living as well as extinct.

There is no doubt as to the great age (pre-glacial) of the plateau deposit of red clay with flints and southern drift, even though the fauna has not been preserved. There remain, however, two other questions to be disposed of, namely: (1) Do the specimens found by Harrison bear marks of use by man or of design in form? — and (2) Are they as old as the patches of clay and drift on the summit of the plateau? Prestwich answers both these questions in the affirmative.

Before formulating answers of my own or even accepting those of another, I determined to study the problems involved at closer range. Photographic reproductions and drawings of specimens shaped into definite patterns may give one absolutely true impressions of the originals. They are, on the other hand, far from satisfactory in the case of the rudely-shaped eoliths. Therefore, I spent a part of the summer of 1903 in Kent with Harrison himself and with Mr Percival A. B. Martin of Chipstead, Sevenoaks, a trained collector and disciple of Harrison. Before going to the field, I made a careful study of the important series collected by both these investigators, who placed themselves as well as their collections unreservedly at my disposal. Mr Martin gave additional facilities in the use of his automobile during my week's stay, thus rendering it possible to accomplish much in a comparatively short time. We made the ascent by the Vigo to the Chalk plateau, and visited many of the best-known stations on the summit. Collections were made at several of these places, especially at Fairseat and in Terry's Lodge pit, opened the previous year by Messrs Harrison and Benton (of Malling) and at their joint expense.

My excursions in Kent were supplemented by visits to the collections of the British Museum at Bloomsbury and South Kensington, as well as to the private collection of Mr W. J. Lewis Abbott at St Leonard's-on-Sea. The eoliths in the British Museum, Bloomsbury, were collected on the North Downs by Harrison.

The larger and more characteristic collection at South Kensington is the gift of Sir Joseph and Lady Prestwich, and includes the specimens figured in Prestwich's "Collected Papers on some Controverted Questions of Geology." These also for the greater part were collected by Harrison.

Mr Abbott, of St Leonard's-on-Sea, was for many years a resident of Sevenoaks and is perhaps as well acquainted with prehistoric Kent as anyone. His collection is one of the most important, and his technical knowledge of the problems involved in the art of chipping flint is of the first order. I spent two days with him, including a visit to the local Museum at Hastings in which he is much interested and where a part of his collection has already been installed. To him and to Messrs Harrison and Martin I am indebted for a number of valuable specimens as well as for information and guidance in the field.

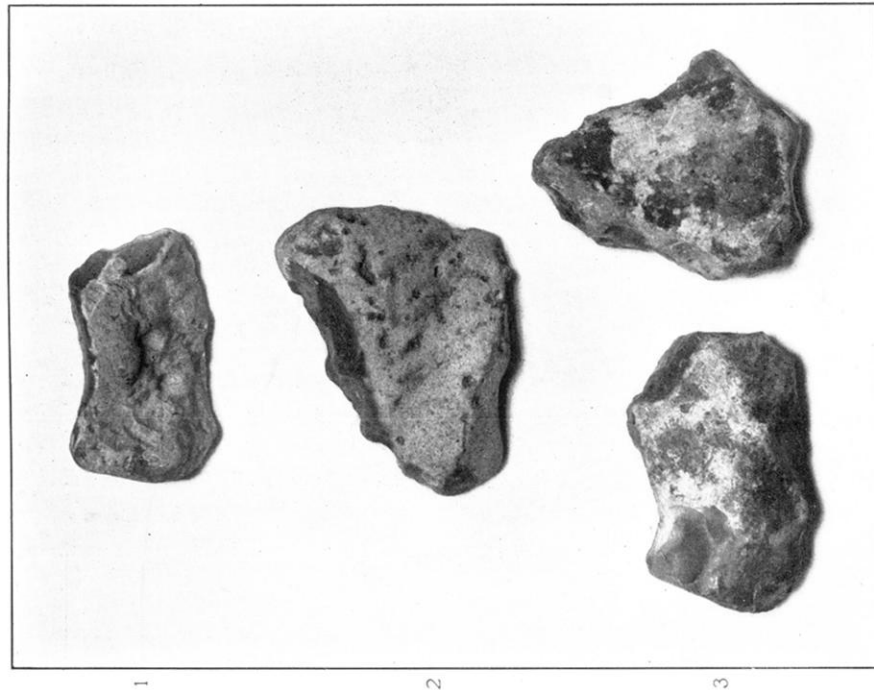
Returning now to the questions already propounded in the light of what I saw in Kent, Sussex, and London, I feel impelled to accept the conclusions of Prestwich, namely, that many of these plateau flints bear the impress of man's handiwork. The marks are often the result of use alone and not of design. This is due partly to the fact that the people of that time did not know how to obtain the raw materials from the chalk, but depended entirely on picking up from the drift natural flakes of approximately the shape and size needed. A sharp edge was utilized once, twice, or until it became dulled, and was then cast aside. The signs of use, though slight, are unmistakable. If an angular piece did not admit of being comfortably grasped in the hand, the troublesome corners were removed. Some pieces were used simply as hammer- or trimming-stones. Perhaps a majority of the specimens show no special design in their shape. Many, however, may be grouped according to more or less definite patterns. Prestwich recognizes three such groups. The first is rather numerous, including thin, flat fragments of flint or natural flakes with chippings and notches along the margins, producing at times rude points; split flint pebbles of Tertiary age with edges chipped to serve as scrapers; and flints that, with a little trimming, could be easily grasped in the hand and used as hammer-stones. The second group is the largest of all and is characterized

by various types of scrapers. Two of these deserve special mention, viz., the small crescent-shaped scrapers comparable to the spoke-shave, and the double scrapers with an intervening point separating the two scraping edges. The third group is small and is represented by various fling-stones and drill-shaped implements.

In every case the eolith does not represent so much a preconceived form of implement as a resultant of a given natural form modified by certain marks of utilization, of adaptation, or by series of retouches. The shape of a chosen flake was not wholly determined by the uses for which it was intended, but was limited largely by the variety in Nature's supply of the raw material. The discovery that knives and forks were the best substitutes for teeth and fingers was not made in a single generation. It is safe, therefore, to assume that it took the combined effort of generations of eolithic experimenters to arrive at the idea of correlating a given form of tool with a given use or series of uses. As long as any flake served the purpose of the workman, Nature's supply sufficed. As soon as it was learned that a certain form of implement served him better in certain instances than any other form, he discovered that it would not do to depend on the chance finding of specimens suited to his growing needs. This led him of necessity to supplement the natural supply, a lesson which was not learned until the beginning of paleolithic times, as we shall soon see.

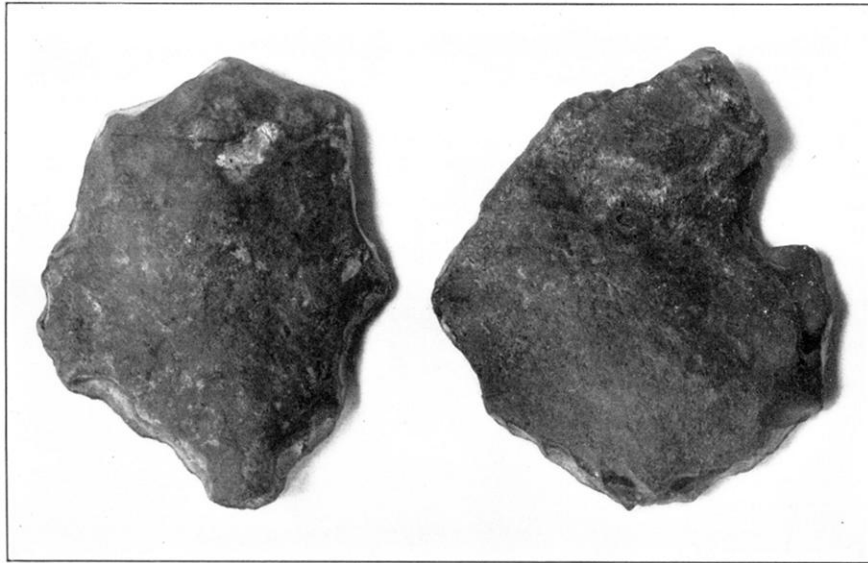
How very different are the valley implements! Their makers no longer depended on pebbles and angular fragments, but knew how to extract the raw material direct from the chalk. With the use of large, fresh, flint nodules, the art of chipping developed rapidly. The establishment of local workshops followed as a logical consequence. Some of these workshops have been left undisturbed so as to make it possible to reconstruct large flint nodules and cores from the numerous chips and implements strewn over a paleolithic floor. Mr F. C. J. Spurrell<sup>1</sup> found such a workshop at Crayford, Kent. The series he obtained there forms an interesting exhibit at the Museum of Natural History, South Kensington. Similar discoveries have been made by Mr J. Allen Brown at Acton, and by Mr Worthington G. Smith at Stoke Newington

<sup>1</sup> *Quar. Jour. Geol. Soc.*, 1880, xxxvi, 544.



*Photo by G. G. Macell.*

A. 1, Farnham, Surrey (p. 435). 2, Farnham, Surrey (p. 435). 3, Terry's Lodge pit, Chalk Plateau, Kent (p. 438). 4, Terry's Lodge pit, Chalk Plateau, Kent (p. 438).



B. 1, Fawkham, Kent (p. 437). 2, Parsonage Farm, Stanstead, Kent (p. 436).

EOLITHS FROM SURREY AND KENT, ENGLAND (ABOUT THREE-FIFTHS NATURAL SIZE)

and Caddington. During the summer of 1900 it was my good fortune to visit several of the clay pits about Caddington in company with Mr Smith and to see in one of the pits a typical paleolithic floor.

Are the plateau implements as old as the drift with which they are associated? Might they not have been dropped on the surface of the Downs in paleolithic or even in recent times? Unpolished neolithic implements may be met with on the surface at any level; but they differ in both form and condition from the specimens in question. Their edges are often dulled, but never water-worn. The originally dark surfaces have taken on a whitish luster and are more or less plough-stained. The eoliths, on the contrary, are uniformly stained on the natural as well as on the worked surfaces, to a deep, ochrous brown color, and usually bear marks of drift action.

The neoliths are confined to the surface, but are not limited geographically. The eoliths are limited geographically, but, as we shall see later, are not confined to surface finds. They are coëxtensive with the old drift. But this drift is found in patches only, much of it long since having been removed from the summit of the Downs by denudation. If the patches that are left yield eoliths, others must have been carried away along with the drift to the valleys below, where one would expect to find them as derived specimens. A few such examples have been obtained after careful search. Figures 1 and 2, plate xxv, A, belong to this category. I found them in a middle terrace gravel-pit near Farnham, Surrey. I also obtained two paleoliths of the usual type from the same pit. The derived implement shown in figure 1 is a natural flint flake, 4.5 cm. in length. The slightly convex surface of fracture is stained bluish white, and the rusty white crust is retained intact over the outer surface. The chipping, which is confined to a single lateral margin, was done with so much care that an overhanging prominence of the external crust, which would be supposed to receive the first ill-directed blow, was left untouched. The prominence might well have served both as a rest and as a protection for the thumb. The specimen shown in figure 2 is likewise a natural flake. It is weathered more deeply than the preceding. The piece is

triangular in shape. The chipping is confined to the longest margin, the blows being given from one direction and in the same plane. Nowhere else is there evidence of even accidental blows.

Harrison's first plateau discoveries were made on the surface, in shallow plough furrows or in trenches and roadside cuttings. Their deep staining, however, led Prestwich to believe that the specimens had been imbedded in a deposit beneath the surface. An implement from a post-hole at Kingsdown, one from a hole dug two feet deep for tree-planting at Parsonage farm, a third from two or more feet beneath the surface in a bank of red clay at the side of a pond, and a fourth at an equal depth in red clay at the Vigo gap, served to strengthen Prestwich's view.

In 1894 the British Association for the Advancement of Science appointed a committee "to investigate the nature and probable age of the high-level flint-drift in the face of the Chalk escarpment near Ightham, which appears to be productive of flakes and other forms of flint probably wrought by the hand of man." A grant was placed at the disposal of this committee, which consisted of Sir John Evans (chairman), Professor Prestwich, Prof H. G. Seeley, and Mr Benjamin Harrison (secretary). Mr Pink, the owner of Parsonage farm, Stanstead, had previously sunk a pit in the drift, and had found plateau implements at a depth of six or seven feet. Adjoining this, the committee's first pit was sunk through two and a half feet of "humus and drifted material, white flints, pebbles, and many ochreous flints worn and worked";<sup>1</sup> three and a half feet of "grey loam, with scattered small pebbles, and a few small, worked, ochreous flints throughout"; and one foot of compact gravel with many worked flints. A second pit was sunk near by and revealed "precisely similar conditions." The latter was sunk to a depth of twenty-six feet, most of the way through Lower Tertiary pebbles without reaching the Chalk. No implements were found below a depth of eight feet.

Through the courtesy of Mr W. J. Lewis Abbott, the Yale University Museum possesses an eolith (plate xxv, B, fig. 2) that was found *in situ* in the first pit sunk on Parsonage farm, Stanstead, the year before work was begun by the British Association. It is a large

<sup>1</sup> *British Association Report*, 1895, p. 349.

natural flake, the greatest diameter being 9.7 cm. The outer surface retains the crust of the original nodule, the inner is stained yellowish brown. In shape it resembles the feline foot, trimmed in the region of the toes, the heel left untouched, and a deep notch near the heel carefully worked. It might have been used as a hammer or trimming-stone, and the crescent-shaped notch near the heel could well serve as a spoke-shave. The specimen represented in figure 1 of the same plate, also the gift of Mr Abbott, is from Fawkeham, some distance to the north of Stanstead. It is a natural flake from the old flint drift, and is much more deeply weathered than the one from the Stanstead pit. Eoliths of this general type may have been used as strigils as illustrated by the Apoxyomenos statue in the Vatican, or after the manner of the natives of Tierra del Fuego, who will not easily part with their much-prized body-stones. In this connection it should be mentioned that the illustrations accompanying this paper are of specimens from the collections made by me during the summer of 1903. Some I found myself, others were obtained from local collectors. All are now the property of the Yale University Museum.

The eoliths figured in plate xxvi, A, were found at South Ash by Mr Benjamin Harrison. Figure 2 is one of the largest eoliths in the Yale collection, its greatest diagonal dimensions being 12 cm. The inner, flat surface is stained to a deep, warm brown color which spreads also over the trimmed edges, where it is only slightly less pronounced in tone. The flake was, therefore, evidently not fresh when first utilized. The working was all done in one direction, the blows being aimed toward the outer crust. Chance chipping would have reduced the somewhat prominent heel which, though angular, serves admirably as a handhold. Figure 1 is a double scraper, with an intervening point between the two scraping edges. The base has been retouched enough to make it fit the hand more comfortably. The worked surfaces are covered with a mottled stain of bluish gray and buff, while the flat surface of fracture has taken on a warmer hue.

Mention has already been made of Terry's Lodge pit opened in 1902 by Messrs Harrison and Benton. On the occasion of our visit to this pit, which is sunk to a depth of about five feet, very near the

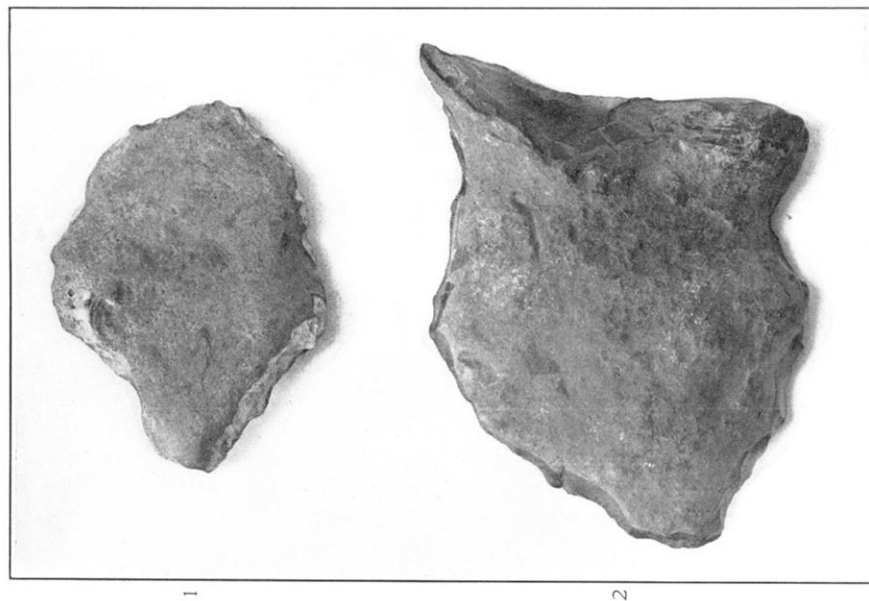
face of the chalk escarpment at a point 700 feet above sea-level, we were successful in finding, after an hour's digging, two specimens<sup>1</sup> *in situ* that were evidently worked. Two worked pieces were also picked up from the heap of clay and gravel thrown out when the pit was first opened. These are both illustrated in plate xxv, A, figs. 3 and 4. They are natural flakes stained to a rich, reddish brown color. The specimen represented by figure 3 is a crescent-shaped scraper of the spoke-shave type, and may be classed with Prestwich's second group referred to on page 434. Figure 4 is an example of the first group. It is roughly triangular in shape; the two margins which meet at the apex are both worked, but on opposite sides. In other words, after chipping one of the margins, instead of rotating the specimen until the adjacent margin was brought into play, it was reversed. Pieces that show reversed chipping would seem to possess special claim to consideration as artifacts. One loves to think of Chance as being unhampered in her actions. It would tend to upset one's habitual regard for her strict impartiality to find her, for instance, not only bunching her blows along a single margin of a flint flake, but also administering them in a given plane and from a given direction. To go further and demand that she should reverse the flake before beginning on an adjacent margin would be to ignore all the rules of probability.

My experiences in the field, as may be inferred, served at every point to strengthen my belief in Prestwich's conclusions; namely, that the plateau specimens bear marks of man's handiwork, and that they sustain the same relation to the old southern drift as the valley specimens do to the gravel terraces in which they are found. Prestwich's views are shared by practically all the many archeologists who have made personal investigations in the field.

Kent is not the only county in which the eoliths occur. Mr O. A. Shrubsole, of Reading, found them in Berkshire soon after Harrison's first discoveries on the North Downs. They have also been found under similar conditions by Martin on the South Downs

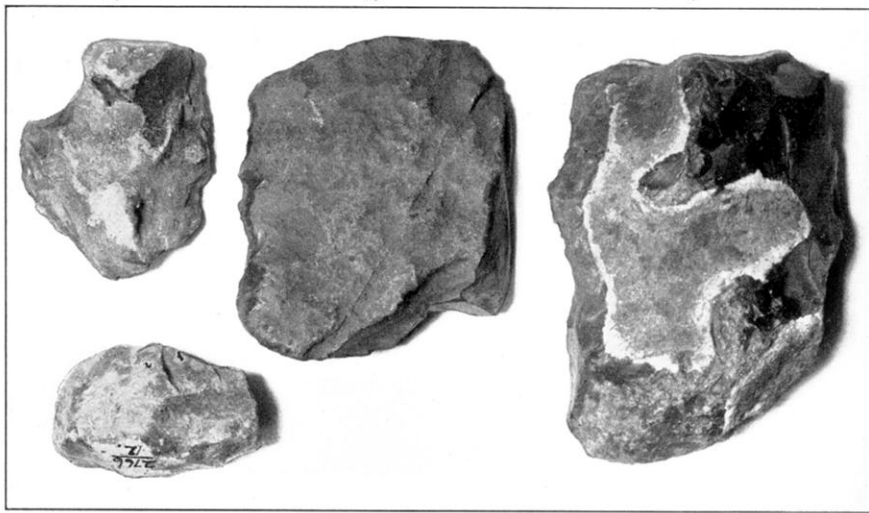
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<sup>1</sup> The best one of these, together with other plateau specimens, was used to illustrate a paper read before Section H at the St Louis Meeting of the A. A. A. S., 1903-04. As it disappeared, mysteriously, on that occasion, I conclude that it must have been convincing to at least one member of the audience.



*Photo by G. G. MacC.*

A. 1, South Ash, Kent (p. 437). 2, South Ash, Kent (p. 437).



B. 1, Harmignies, Belgium (p. 461). 2, Harmignies, Belgium (p. 460). 3, Bois d'Épinois, Belgium (p. 461). 4, Harmignies, Belgium (p. 460).

COLITHS FROM ENGLAND AND BELGIUM (ABOUT THREE-FIFTHS NATURAL SIZE)

at Beachy Head, near Eastbourne, Sussex ; by Blackmore, Bullen, and others near Salisbury, Wilts ; and in Dorset ; also in Surrey, Hampshire, the southern part of Essex, and Norfolk. For details of the various discoveries, the reader is referred to the bibliography accompanying this paper.

The deposits investigated by Shrubsole consist of pre-glacial gravel beds, from five to ten feet in thickness, that cover "the summit of an elongated plateau stretching from Easthampstead, Berks, to Ash Common, near Aldershot." They are composed of the same southern drift that has furnished the implements found on the North Downs, and had their origin in the heights that once rose over what is now the Wealden district to the south and southwest.

The gravel-capped plateau rises to an average level of about 400 feet above the sea, and "forms the highest ground between the rivers Wey and Blackwater." The specimens described came chiefly from Finchampstead, Easthampstead, and from near Bagshot. They present precisely the same general aspect as do those from the North Downs. Shrubsole believes them to be as old as or older than the gravel beds. His opinion is based on their mineral condition, and on the fact that he, himself, took them "from the gravel freshly fallen from the face of the pits, or from the heaps of screened gravel in the pits." It is pointed out that no artificial flakes and no implements of the amygdaloid type have been found in these gravels—a bit of negative evidence that gathers much weight when correlated with evidence of the same nature from other parts of the country.

The gravels rest upon what Shrubsole calls the Upper Bagshot. But, according to Geikie,<sup>1</sup> there is no marked separation between the Upper and the Middle Bagshot series in the London basin. They may be, therefore, of either Middle or Upper Eocene age. The gravels capping them are newer ; probably Upper Pliocene, since Prestwich was disposed to regard them as corresponding broadly in time with the Chillesford and Forest-bed groups, and these are Upper Pliocene.<sup>2</sup> If fluvial, they "would be the work of a stream which for a long time has ceased to exist, since its bed

<sup>1</sup> *Textbook of Geology*, 4th ed., 1903, p. 1233.

<sup>2</sup> *Ibid.*, p. 1281.

now occupies the summit of a hill-range, and on the sites of the former hills are now river valleys."

Dr H. P. Blackmore's discovery at Dewlish, Dorset, of eoliths associated with the remains of *Elephas meridionalis* was announced to the Victoria Institute in 1900, through a letter to the Rev. R. Ashington Bullen. The Blackmore Museum in Salisbury is of special interest to Americans because it contains the famous Squier and Davis collection of antiquities from the Mississippi valley, purchased by Blackmore before its value was appreciated in this country. The same museum now possesses an important collection of eoliths. Many of these were found by Dr Blackmore in the Alderbury gravels near Salisbury, he having taken them out of the gravels at all levels, to a depth of fourteen feet, with his own hands. These Alderbury gravels were classed as Southern Drift by Prestwich. Like the deposits on the Kent plateau, they are not fossiliferous. They rest upon the Bagshot sands, and "are at a much higher level than the river drift, which furnishes both flint paleolithic implements and a very good list of Pleistocene mammals and shells."

The Alderbury gravels are exploited largely for road-metalling; and for twenty years, at least, the pits have been searched in vain for implements of the well-known paleolithic type. On the other hand, specimens of this type are fairly plentiful in the river-drift terraces of the neighborhood.

In his effort to establish the age of the eoliths by means of paleontological evidence, Dr Blackmore had recourse to a patch of gravel in Dorset, where his grandfather had found a molar of *Elephas meridionalis*, as long ago as 1813; and where he, himself, was present at the discovery, in 1887, of the remains of *Elephas meridionalis* now in the Dorchester Museum.

Dr Blackmore, in describing his search for eoliths, writes:

"Being very anxious to fix the Pliocene age of these eoliths [meaning those from near Salisbury], rather more than a year ago I went down to Dewlish, in Dorset, with the express purpose of carefully examining the gravel which had furnished the remains of *Elephas meridionalis*, as this was the one spot in the South of England which was regarded as a patch of Pliocene gravel.

"The farmer, Mr. Kent, on whose land the elephant remains were

found, was fortunately known to me, and he furnished me with two labourers. A trench was opened through the deposit of gravel, and there was no difficulty in finding eoliths, stained like the gravel, at the same level and associated with the elephant bones. This was to me most satisfactory and conclusive."

A recent letter to me from Mr Percival A. B. Martin describes a new locality for eoliths about six miles west of Eastbourne, as follows:

"The plateau drift caps a hill that is about 600 feet above sea level, and evidently belongs to the same spread of drift as that at Beachy Head, which also was the bottom of a very ancient valley, the vestiges of which are now preserved only on the very highest points of the district."

The Chalk cliffs at Beachy Head are familiar to every Channel voyager. The Chalk suddenly disappears at Eastbourne and does not reappear until one is opposite Dover, a distance of more than 50 miles. It is not generally known that the cliffs at Beachy Head and Dover are the bases of a great anticlinal fold whose axis passes from Dungeness in a westerly direction through Hampshire. The crest of the fold, including not only the Chalk beds but also the underlying strata of Upper Greensand, Gault, Lower Greensand, and Weald, has disappeared. If, before it disappeared, the old drift and eoliths were transported northward and left on the North Downs, the same old drift with eoliths must have been carried southward and deposited on the South Downs. A line drawn from Ash to Beachy Head would cut the axis of the fold at right angles. Martin thought he ought to find the old drift with eoliths at Beachy Head, and we have just seen how his search has been rewarded.

Both plateaus are but slender tongues from the great Chalk plain of Dorset, Wiltshire, and Hampshire, the tip of one being at Dover, that of the other at Beachy Head. Each will be explored eventually throughout its extent. The Chalk plain itself may be relied on for localities other than those already discovered. The Chalk is also continuous all the way from Dorset and Salisbury Plain in a northeasterly direction to Cromer on the Norfolk coast. At the southwestern extremity of this Chalk belt Dr Blackmore found eoliths associated with the remains of *Elephas meridionalis*; at its northeastern extremity, Abbott found a like association in

deposits of the same age. The results of the researches of Worthington G. Smith at Caddington, near Dunstable, about midway between Dewlish and Cromer, are an indication of the possibilities of the entire Chalk belt.

Mr W. J. Lewis Abbott's discovery, mentioned above, was made while searching the *Elephas* deposits of the Cromer Forest bed, to the west of East Runton. In the same level with *Elephas meridionalis*, Abbott found several worked flints, two *in situ*; others, because of their peculiar staining, evidently from the same bed. I saw these specimens, and with Abbott believe in their artificial character. Rutot, of Brussels, to whom Abbott sent the specimens for examination, is of the same opinion. An added interest attaches to the Forest bed implements in view of the recent researches by Laville and Rutot in the Upper Pliocene deposits at Saint-Prest, near Chartres, the station that came into prominence nearly forty years ago through the discoveries of the Abbé Bourgeois.

#### BELGIUM

Reference has already been made to early discoveries bearing on a pre-paleolithic industry in France and Portugal. In recent years the theater of interest and action has centered in Belgium, owing largely to the researches of Dr A. Rutot, of the Royal Museum of Natural History, Brussels. Admirably fitted by special training in engineering and geology, Rutot early took up the study of the Belgian Quaternary. This work led naturally to the subject of prehistoric anthropology (Quaternary and Pliocene), and to the work of such men as Gabriel de Mortillet. But Rutot did not believe in the new faith preached by de Mortillet, and in laying deep and broad plans to compass its destruction, he was led gradually to the conclusion that some at least of its tenets were true in the main. The chief difficulty was that, being in advance of his time, de Mortillet's work lacked the benefit of that constructive criticism without which a founder's work is apt to prove faulty when the time comes to add the superstructure. Rutot has endeavored to retain the sound construction and to eliminate the faulty. The foundations have been enlarged, and there has arisen a superstructure embodying as nearly as possible the ideas that are likely

to survive. The chief cornerstones of the Rutot edifice are stratigraphy and paleontology.

It must not be inferred that Belgium had contributed nothing toward a solution of the eolithic problem before Rutot's time. The name of Gustave Neyrinckx has already been mentioned in connection with the committee appointed by the International Congress of Anthropology and Prehistoric Archeology (held at Brussels in 1872), to pass judgment on the Thenay specimens presented by the Abbé Bourgeois. To Neyrinckx belongs the honor of being the first discoverer of eoliths in Belgium; but he did not live to see the fruits of his discovery mature. The value of his pioneer work is now recognized, and the specimens he found in the newly-made railway cut at Mesvin, between Mons and Harmignies, in 1868, are now a highly-prized possession of the Royal Museum of Natural History, Brussels. M. Émile Delvaux next took up the work at Mesvin, where he succeeded in determining stratigraphically a pre-chellean industry to which he gave the name Mesvinian — an epoch that Rutot later embodied in his system of prehistoric chronology.

But the pre-chellean industry at Mesvin is Quaternary and not Tertiary. This fact is of prime importance for several reasons. The industry-bearing deposits of Puy-Courny are accepted as Upper Miocene. Those of the Chalk plateau are Middle Pliocene, according to Rutot; and those of Saint-Prest, the Cromer beds, and Dewlish, are Upper Pliocene — all of Tertiary age. Further, according to the de Mortillet chronology which appeared in 1894, and again in 1900, all pre-chellean implements were classed as Tertiary. The amygdaloid implement was supposed to date back as far as the beginning of the Quaternary; to be, in fact, the only type of early Quaternary artifact — a supposition without foundation, as has been abundantly proved by Rutot and his colleagues in Belgium. The error arose from taking the river drift of Chelles as a type station, and from lack of a systematic study of undisturbed Quaternary deposits. In his exhaustive studies of scores of Belgian stations, Rutot has supplied this deficiency. A correlation of the data thus gathered has not only thrown a flood of light on the work of earlier investigators, but has also illumined hitherto

untrodden fields, and points the way to a future full of promise to the student of the prehistoric.

Turning from the Tertiary eoliths of France and England, let us consider the Quaternary eoliths of Belgium. Rutot's search for eoliths was much simplified by his early recognition of the two conditions essential to their occurrence, viz.: (1) The presence in abundance of utilizable raw material on the surface of the soil, either in the outcropping of Cretaceous flint-bearing rocks, and the clays due to the decomposition and dissolution of the chalk; or in the valley drift; and (2) Proximity to a water course. These conditions obtained at the very beginning of the Quaternary in most of the river valleys of Belgium.

These valleys are often marked by three terraces: the upper terrace, about 90 meters above the present water-level, of Pliocene age; the middle terrace at an elevation of from 25 to 65 meters, and the lower terrace a little above flood water-level, both of Quaternary age. One would expect to find the first Quaternary industry in the stony deposit (*cailloutis*) that forms the base of the middle terrace in regions not covered (and the regions in question were not) by the Continental ice-sheet. This deposit marks the very close of the Pliocene, but the flints contained in it were utilized at the beginning of the Quaternary and before the superimposed beds were formed.

The accompanying section (figure 16) of the valley of the Lys south of Ypres shows the three terraces and the disposition of the various Pliocene, Quaternary, and recent deposits. Eoliths were found in deposit G. To the industry occurring in deposits of this age, Rutot has given the name Reutelian, from the hamlet of Reutel, to the east of Ypres, where a typical station on a large scale is to be found. Morphologically, these earliest Quaternary implements resemble in every respect the more ancient Tertiary eoliths. The name Reutelian, therefore, is to be understood as having a stratigraphical significance only.

The Reutelian industry varies lithologically according to the varying character of the material utilized. In West Flanders, for example, nodules of grayish black flint coming from the Cretaceous outcrops on the height of Artois were used exclusively. These

nodules were easily transformed into anvil- and hammer-stones, while natural flakes served as scrapers. There is no evidence that nodules were purposely broken up to obtain artificial flakes, the supply of natural ones being quite plentiful at first.

Reutelian implements have been found not only in stratigraphic section, but also on the surface of the soil where denudation has left the deposits in question exposed; and this is especially true of gently sloping hillsides facing the southwest, from which direction

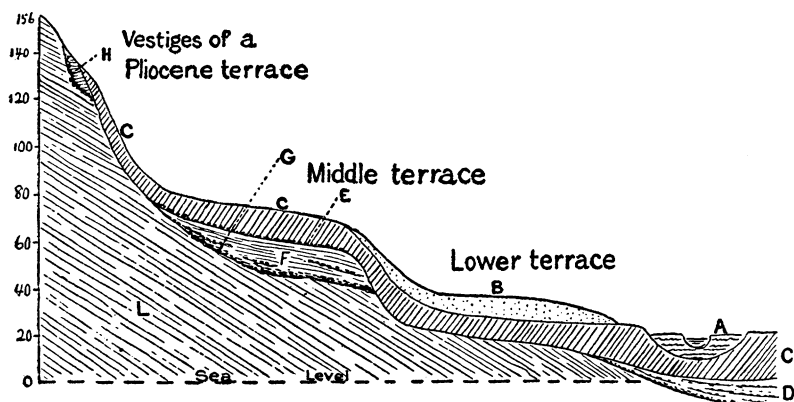


FIG. 16. — Section of the valley of the Lys to the south of Ypres, showing the three terraces and the disposition of the Pliocene, Quaternary, and recent deposits (after Rutot). *A*, Recent alluvium (sand, clay, peat). *B*, Marine sands of Flandrian age (Upper Quaternary). *C*, Stratified Hesbayan clays (Middle Quaternary). *D*, Campanian alluvium; argillaceous sand and gravel with fauna of the Mammoth (Middle Quaternary). *E*, Flinty layer at the top of the Mosean with mélange of Mesvinian and Chellean industries. *F*, Mosean alluvium (Lower Quaternary). *G*, Flinty layer forming the base of the middle terrace (Reutelian industry). *H*, Vestiges of a Pliocene terrace. *L*, Marine deposits (Eocene).

come the prevailing winds and rain. So thoroughly has Rutot mastered the problems at issue that it has been possible for him to foretell the locality where a certain industry may be found, simply by consulting his geological maps.

The geographic distribution of the Reutelian industry includes: the valley of the Lys, particularly in West Flanders; the region about Harmignies, east of Mons; both banks of the Haine and its tributaries, from the French frontier to Morlanwelz; the valley of the Sambre, 25 meters and upward above the river bed, especially

in the neighborhood of Landelies, also at Tamines, Floreffe, and finally at Salzinnes, near the confluence of the Sambre and the Meuse; the valley of the Meuse to the south (at Wépion) and east of Namur; sparsely in Limburg, but over a large area; and in the extreme east, near Spa. The same industry has already been found in France at Guise, valley of the Oise; Bicêtre, near Paris; and Saint-Prest near Chartres, valley of the Eure. Dr Hahne's recent discoveries at Schönebeck, in the valley of the Elbe, seems to prove the presence of Reutelian implements in Germany.

Industrial remains have also been found in the stony deposits that form the base of the lower terrace in non-glaciated regions — deposits synchronous with the retreat of the first Quaternary glacier, while the Reutelian epoch corresponds with the advance of the same glacier. The implements found at the base of the lower terrace do not differ technologically from the Reutelian eoliths. The only difference is in their stratigraphic relations. A good example of their occurrence is to be found in the quarries of Maffle, near Ath, valley of the Dendre (figure 17); hence the name Mafflean suggested by Rutot for this epoch. It has also been styled Reutelo-mesvinian, a name suggested by its transitional position between the epoch which precedes, and the one which follows, called the Mesvinian.

The geographic distribution of the Mafflean or Reutelo-mesvinian industry is not nearly so extended as that of the Reutelian. It is confined to the lower valley terraces, and only to those that contain utilizable material. The principal Reutelo-mesvinian stations of Belgium are: Maffle, valley of the Dendre; the environs of Binche, valley of the Haine; Quiévrain, Baisieux, Audregnies, etc., valley of the Hogneau; the environs of Charleroi, Aiseau, Tamines, etc., valley of the Sambre; Wommersom, valley of the Grande-Geete, and Saint-Symphorien, Spiennes, etc., valley of the Trouille.

The specimens figured in plate XXVII, A, are natural flakes of phthanite, each provided with a sharp margin at right angles to the opposite, tapering end, or natural handle. In both cases, the once sharp margin has been dulled by use as a scraper. They are from the base of the Mosean (Lower Quaternary) in the Exploitation Hardenpont, at Saint-Symphorien, east of Mons, where the industry is unmixed with that of any other epoch.



Photos by G. G. MacC.

A. Saint-Symphorien, near Mons (p. 446)



B. Exploitation Helin, near Spiennes (p. 462)

EOLITHS FROM BELGIUM (ABOUT THREE-FIFTHS NATURAL SIZE)

It is interesting to note that M. Cels was the first to call attention to the existence of chipped flints at the base of a lower terrace, viz : the works between Spiennes and Saint-Symphorien, known as the Exploitation Helin, to which station we shall have occasion to refer at length. This was in 1888, when the knowledge of Quaternary geology, as well as of eoliths, was scarcely more than a blank ; hence Cels' observations<sup>1</sup> attracted little attention save opposition from the geologists.

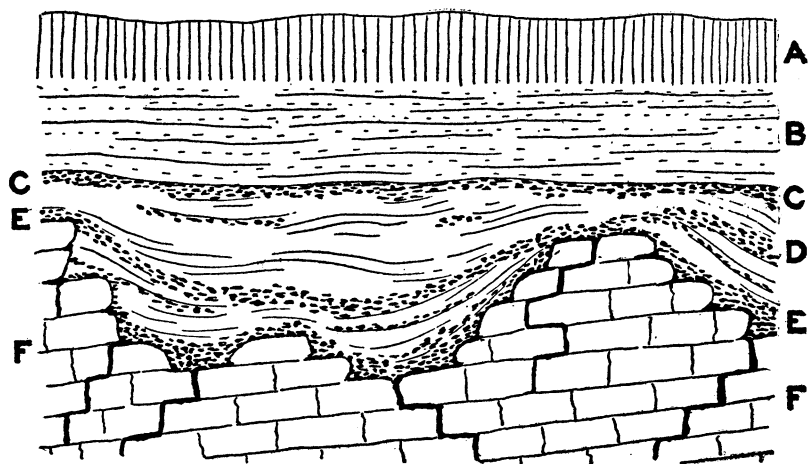


FIG. 17. — Section of the lower-terrace Quaternary deposits in the quarries at Maffle, near Ath, valley of the Dendre (after Rutot). *A*, Brick-earth, summit of the Flandrian. *B*, Stratified, sandy clay, the so-called *ergeron* of the Flandrian. *C*, Flinty layer at the summit of the Mosean, with many utilized pieces of flint and phthanite (Mesvinian industry). *D*, Mosean fluvial sands with stony layers (utilized pieces of flint and phthanite). *E*, Flinty layer, base of the Mosean (Reutelo-mesvinian or Mafflean industry). *F*, Carboniferous limestone.

The Reutelo-mesvinian, as might be expected, is found at the base of the lower terraces in France. La Fère, valley of the Oise, is a typical station. The gravel pits in the lower terraces about Paris (Billancourt, Chelles, Cergy, etc.) have yielded specimens of this class, mixed, however, with those of the succeeding Mesvinian and Chellean epochs, the mixture being due to the disturbed character of the drift deposits. The Mafflean industry occurs in its purity at Erith, valley of the Thames. Here the immediately overlying stratified sands con-

<sup>1</sup> *Bull. Soc. d'anthr. de Bruxelles*, VI, 156.

tain remains of *Elephas antiquus* and freshwater- and land-shells, including *Corbicula fluminalis*. Two stations in Germany also deserve mention — one in the valley of the Elbe, the other at Taubach, near Weimer.

In Belgium there is no trace of glacial action properly so called — no moraines, no boulder clay. All the Quaternary deposits of Belgium, then, are either marine or fresh-water with the exception of a single bed of probably eolian origin. Belgian Quaternary may be easily divided into five series of deposits. Beginning with the oldest, these are: (1) Mosean, (2) Campinian, (3) Hesbayan, (4) Brabantian, (5) Flandrian.

The Mosean consists of a marine and a continental facies. The fauna of the lower marine deposits closely resembles the present marine fauna of the Belgium coast. The upper layers of the marine facies have furnished remains of the *Bison*, *Cervus*, *Elephas antiquus*, *Rhinoceros merckii*, and *Hippopotamus major*.

The Campinian deposits are fluvial gravels and sands with cross stratification, localized in the bottom of valleys. They are often rich in remains of *Elphas primigenius*, *Rhinoceros tichorhinus*, *Equus caballus*, *Ursus spelæus*, *Felis spelæa*, *Megaceros hibernicus*, *Bison europæus*, etc.— the so-called fauna of the Mammoth.

The Hesbayan stratified clays, 20 to 30 meters thick, and covering the greater part of Belgium, are never ossiferous. The only fossils are: *Helix hispida*, *Succinea oblonga*, and *Pupa muscorum*, none of which is characteristic of the Hesbayan.

Brabantian is a name new to geology, employed for the first time by Rutot, and dating from the year 1900. The term represents the period of desiccation following the deposition of the enormous Hesbayan beds. It designates the pulverized, non-stratified clays, eolian in character, and derived from the Hesbayan clay mantle. These are found notably in Brabant, and are never fossiliferous.

The Flandrian, the last division, like the Mosean, has both a marine and a continental facies. The fauna of the marine facies is analogous to that now living on the coast of Belgium. Of the two continental layers, the lower consists of stratified sands and clays (ergeron), and the upper is composed of brick-earth. The fauna of the continental deposits is confined to the lower layer (ergeron), and

consists solely of the shells already mentioned under the Hesbayan, viz.: *Helix hispida*, *Succinea oblonga*, and *Pupa muscorum*.

All these Quaternary deposits have been carefully examined by Rutot in a search for industrial remains. The Mosean beds are divided into four layers: (1) Lower gravels, (2) Stratified sands and gravels, (3) Loam, and (4) Upper gravels. The lower Mosean gravels occur at the base of the middle terrace and also in the lower terrace. In the middle terrace they contain the Reutelian industry; and in the lower terrace, the Reutelo-mesvinian. The industry of the second layer, stratified sands and gravels, when present, is Reutelo-mesvinian. The loam is generally destitute of implements, while those of the upper Mosean gravels, by reason of their stratigraphic position, are placed in a class by themselves, to which is given the name Mesvinian — a term first employed by M. Émile Delvaux to describe the rude implements found in the railway cut at Mesvin, between Mons and Harmignies.

The Mesvinian industry, then, occurs in deposits that cover the Mosean loam of the middle and lower terraces of valleys in non-glaciated regions, and, according to Rutot, is synchronous with the beginning of the first phase of the second Quaternary glacier. This industry is still of the purely eolithic type, the only novel feature being a notable increase in the percentage of flakes obtained by artificial means — an increase due to the scarcity of natural flakes in these particular deposits.

The geographic distribution of the Mesvinian is quite extensive. In addition to the well-known stations at Mesvin, near Mons, and the Exploitation Helin, at Spiennes, also near Mons, it occurs in the middle terrace of the valley of the Lys and the lower terrace of the valley of the Dendre. Many stations have been uncovered in the valley of the Haine and its tributaries, at Quiévrain, Saint-Symphorien, and Haine-Saint-Pierre, through recent activity in the production of phosphate of lime. Two other localities worthy of mention are in the valley of the Sambre — at Aiseau in the lower terrace and at Salzinnes les-Namur in the upper terrace.

At least two Mesvinian stations are known in England — at Erith, valley of the Thames, and at Chacely, near Tewkesbury, valley of the Severn — each in a lower terrace. In France, the

same industry is to be found in the upper terrace at Saint-Prest and Amiens; also at Chelles and Cergy. To these may be added Germany's contribution from Rixdorff and from Britz and Rudesdorff, near Berlin. Rutot places also in this category the chipped flints recently discovered by Dr G. Schweinfurth at Thebes.

The present valleys were begun during the Middle Pliocene. They were cut deeper during the Upper Pliocene. With the Lower Quaternary or Mosean, the cutting was localized between the upper and middle terraces. The maximum erosion was reached with the Campinian, or first phase of the Middle Quaternary. The valleys were subsequently filled to the extent of 15 to 30 meters in some instances. It is near the base of the Campinian that Rutot has found what he considers to be the transition from the Mesvinian to the Chellean — in other words, the transition from the eolithic to the paleolithic period. This transition epoch, called by Rutot the *Mesvino-chellean*, is important from the point of view both of stratigraphy and technology, and represents the turn in the tide of the affairs of primitive man. It means that the eolithic period did not close with the Tertiary, as de Mortillet believed, but that it continued on through the Lower into the Middle Quaternary, as Rutot has proved.

A good example of the character of the evidence on which Rutot's classification rests is to be had in the *Exploitation Helin*, at Spiennes, near Mons. The industry-bearing Campinian beds hitherto studied had been fused into one, in which were found a *mélange* of flint chips resembling eoliths, of flint nodules only slightly shaped into rude amygdaloid forms, rude Chellean implements with base formed by reserving the nodular crust, as well as the classical Chellean and Acheulian types. Were these all various manifestations of one and the same industrial epoch; or did they represent the successive steps in a gradual industrial evolution? The answer to this question depended on finding the layers separated stratigraphically, a condition that was known to exist at the old *Exploitation Helin*, phosphate works at present owned by the *Société de Saint-Gobain*.

By permission of the proprietors and authorization of the director of the Royal Natural History Museum, Brussels, a thorough

investigation of the complete section was made in October, 1902, under the personal direction of Dr Rutot. Beginning at the bottom, the section (figure 18) shows the following:

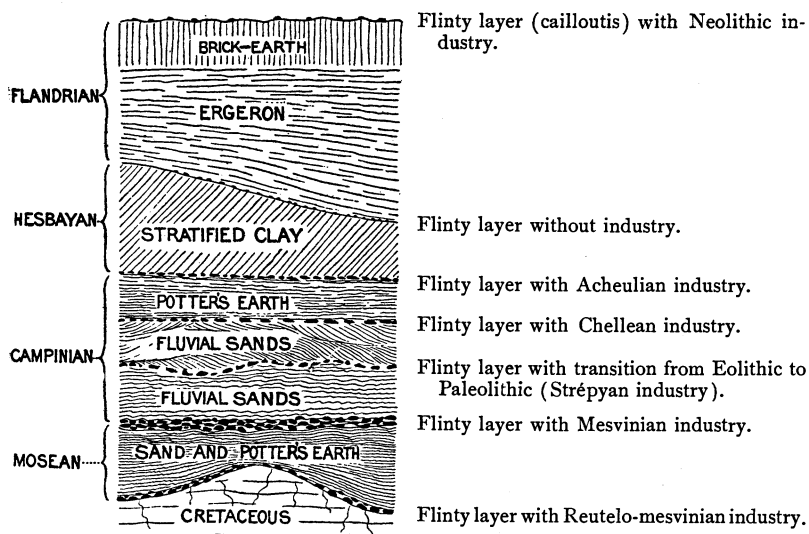


FIG. 18. — Section of the Exploitation Helin, near Spiennes, showing the superposition of the Quaternary deposits; lower terrace of the valley of the Trouille (after Rutot).

1. Stony deposit at the base of the Mosean resting on the Chalk and containing a pure Reutelo-mesvinian industry (the Exploitation Helin is in the lower terrace of the Trouille valley).

2. Fluvial clays and sands, without industry.

3. Stony layer at the summit of the Mosean, with pure Mesvinian industry.

4. Stratified fluvial sands that in neighboring pits have furnished remains of the mammoth.

5. A thin, irregular, flinty layer with the transition industry, Mesvino-chellean.

6. Fluvial sands irregularly and obliquely stratified.

7. A horizontal flinty layer, with the well-known Chellean type of implement.

8. Regularly stratified loam, with traces of vegetable earth at the top.

9. A very thin flinty layer, with typical Acheulian industry.

10. Hesbayan clays.

11. Thin flinty layer, without industry.
12. Stratified sands and clays (erguson).
13. Brick earth.

It will be seen that all five divisions of the Quaternary, with the exception of the Brabantian which is above the eolithic zone, are represented in section at the Exploitation Helin. All of the Quaternary eolithic epochs are likewise represented here with the exception of the oldest, the Reutelian.

But Rutot's attention was centered on the three separated industry-bearing Campinian layers. Would they each furnish one of the several elements composing the industry already found elsewhere in disturbed Campinian deposits? They did. The lowest of the three (layer no. 5) contained not only eoliths of the Mesvinian type, but also rude implements roughly amygdaloid in shape, selected flint nodules only slightly chipped to a semblance of the hache type, or the poniard. It thus answers all the requirements of an industry of transition between that of the Mesvinian level (no. 3) and that of layer number 7, where Rutot found the classical "*coup de poing*." In the uppermost of these three layers (no. 9) were specimens of the amygdaloid and hache types, carefully chipped on both sides until the margins presented almost a straight line as opposed to the zigzag margin of the Chellean implement — in other words the so-called Acheulian industry of M. d'Ault du Mesnil and the French school.

These Campinian bands consist almost exclusively of blocks of flint and artificial flint chips. They form what is known in England as paleolithic floors. These floors had been so little disturbed that both Rutot and M. É. de Munck were able to replace numerous flakes on their respective cores, building up in this manner the original flint nodules once more. All the edges of the flakes were as sharp as they would be had the chipping been done only yesterday.

The importance of the discovery of a transition industry between the eolithic period representing a low plane of mentality reflecting practically no industrial development, and the paleolithic period, signalized by a gradual evolution both mechanical and mental, cannot well be overestimated. The data gathered at the Exploitation Helin might not of themselves suffice to establish the existence

of a transition stage ; but when supplemented by the rich finds along the right bank of the Haine between Estinnes and Cronfestu, notably at Strépy, Maurage, Trivières, and Saint-Vaast, the cumulative evidence is irresistible. The industry, in fact, is so abundant and characteristic at Strépy as to justify Rutot's proposal of the name Strépyan for the transition epoch, in place of the longer term Mesvino-chellean.

The Exploitation Helin, with its separated, industry-bearing, Campinian layers, is the key to the passage from the eolithic to the paleolithic period. It furnishes the solution of the problem of the mixed industries occurring at various localities along the northern shore of the Haine, particularly at Strépy. These localities, on the other hand, have furnished the transition industry in far greater quantities and variety of form. The gently sloping valley facing the southwest being exposed to the prevailing winds and rainstorms, the beds of clay have disappeared. The result is that two of the flinty layers are fused into one. The probability of a mixture of industries was suggested by the fact that two kinds of flint were utilized : (1) small nodules of a green-coated brown flint, and (2) flakes artificially removed from large nodules of beautiful black flint. By placing in one group the artifacts of brown flint, and in another those of black flint, Rutot discovered that he had by that act separated two industries as perfectly as they had been separated in the section at the Exploitation Helin. There were, for example, no carefully fashioned implements of the Acheulian type among the brown flints, and no rude Chellean implements among the black flints.

The almost incredibly rich finds made at Strépy and neighboring localities have served to shed new light on the uses to which the artifacts were put. The first unmistakable weapons are placed by Rutot in the Strépyan (transition from the eolithic to the paleolithic). The eoliths are tools and not weapons, with the possible exception of the small fling-stones, and these were evidently not weapons of defense, being used only in the chase.

The transition industry includes hammer-stones, scrapers, and punches, all of which retain eolithic facies while undergoing a gradual evolution in form. To these may be added an entirely new

series of implements more or less amygdaloid in shape, i. e., the primitive Chellian "*coup de poing*."

Rutot's ingenious theory as to the origin of the amygdaloid type of implement is given here, because of its plausibility and because I had arrived, independently, at the same conclusion after a careful study of the transition series belonging to the Yale Museum. The primitive stage is the rather flat flint nodule, with more or less rounded contours, such as would attract one in search of a hammer-stone. With use, small chips would be detached from a section of the contour. Some would be removed from one face, and some from the other, as the aim veered to the right or to the left as the case might be. This would result in an irregular, zigzag edge for which uses might easily arise. By bringing an adjacent section of the contour into play as a hammer-stone, the zigzag edge could be extended indefinitely. The specimens show that, in practice, it was wise to reserve the original handhold.

An excellent example to illustrate the hammer-stone origin of the almond-shaped paleolithic may be seen in figure 2 of plate XXVIII, B. The implement, which comes from Bray, valley of the Haine, is a flint nodule with smooth exterior. About one-half has been reserved for the handle. The borders of the other half are chipped and battered by hammer-like blows. The flakes removed being blunt, the thickness of the nodule toward the center is not reduced, and the worked edges are, in consequence, quite blunt. From the accidental chipping of a hammer-stone in use to further intentional chipping and retouching, with a view of rendering the original nodule flatter and its edges straighter and sharper, is but a step, and that step was taken as soon as its utility became evident.

The amygdaloid implement serves equally well as a hatchet or a poniard, and is, therefore, an excellent all-round weapon. In the meantime, a veritable poniard was in process of development. It was evolved from the sub-cylindrical flint nodule. A few well-directed blows at one extremity, and the poniard was ready for service. Its greater length, better handhold, and sharper point rendered it more effective for thrusting purposes than was the composite amygdaloid implement. Of the two hundred or more rude, flint poniards in the Brussels collection, some have very serviceable,

natural guards, the maker having selected a nodule with an enlargement at the proper place — a further step in the differentiation between the hilt and blade.

Perhaps no better intermediate form between the amygdaloid type and that of the poniard could be found than the two specimens illustrated in plate XXIX, A. They are enough alike to have been made by the same workman. Figure 1 is from Milton Street, about 100 feet above the Thames and near the base of Swanscombe hill (figure 15). Figure 2 is from the Shelly gravel-pit at Swanscombe, which is very near Milton Street and at approximately the same level above the Thames. Both were given to me by Mrs Stopes, whose husband, the late Henry Stopes, found them in 1900. Each is simply a sub-cylindrical nodule, chipped at one end to a blade-like, rather sharp, edge. The patina of the chipped surfaces is especially rich and glossy. The specimen from Milton Street is provided with a natural hilt that fits the hand perfectly and is more suggestive of the poniard than of the strictly Chellean type.

The implement from the Shelly gravel-pit at Swanscombe has no differentiated hilt, but the blade near the point is chipped so thin as to make it admirably adapted for use as an instrument of thrust. It was associated with a comparatively rich fauna, including *Elephas antiquus*, *Elephas primigenius* and *Corbicula fluminalis*.

The mixed character of the fauna, as well as of the industry, leads me to believe that the industry of the Shelly gravel-pit at Swanscombe represents both the eolithic and the paleolithic.

The section of the pit that has yielded so many fossils and stone implements is described by Mr Stopes as "stratified sands and gravels, capped by a thin layer of tough clay." The Shelly bed is 10 feet thick, and rests upon the Chalk at a level of 78 feet above the sea. In it were found the implements also; but whether at a single level or at various levels is not stated.

I have compared a list of the Shelly gravel-pit<sup>1</sup> fauna with those furnished by Rutot for the deposits at Erith and Menche-court, each in a lower terrace; and that by Laville for Cergy, also in a lower terrace, only 7 meters above the mean water-level of the Oise. The results are as follows:

<sup>1</sup> Mrs Stopes in *Report Brit. Assoc. for the Adv. of Science*, Southport, 1903.

## MAMMALIA.

<i>Cervus elephas</i> ,	Swanscombe, Erith, Menchecourt.
<i>Elephas antiquus</i> ,	Swanscombe, Erith, Menchecourt, Cergy.
<i>Elephas primigenius</i> ,	Swanscombe, Erith, Menchecourt, Cergy.
<i>Equus caballus</i> ,	Swanscombe, ..... Menchecourt, .....
<i>Rhinoceros leptorhinus</i> ,	Swanscombe, ..... Cergy. <sup>1</sup>
<i>Sus scrofa</i> .....	Swanscombe. .... Menchecourt, Cergy.

## MOLLUSCA.

<i>Carychium minimum</i> ,	Swanscombe, ..... Cergy.
<i>Helix nemoralis</i> ,	Swanscombe, ..... Cergy.
<i>Limnæa auricularia</i> ,	Swanscombe, ..... Cergy.
<i>Limnæa peregra</i> ,	Swanscombe, Erith, .....
<i>Limnæa palustris</i> ,	Swanscombe, Erith, .....
<i>Planorbis spirorbis</i> ,	Swanscombe, Erith, ..... Cergy.
<i>Bithinia tentaculata</i> ,	Swanscombe, Erith, Menchecourt, Cergy.
<i>Valvata piscinalis</i> ,	Swanscombe, Erith, ..... Cergy.
<i>Valvata cristata</i> ,	Swanscombe, Erith, .....
<i>Unio littoralis</i> ,	Swanscombe, Erith, .....
<i>Corbicula fluminalis</i> ,	Swanscombe, Erith, ..... Cergy.
<i>Sphæricum corneum</i> ,	Swanscombe, Erith, .....
<i>Pisidium amnicum</i> ,	Swanscombe, Erith, ..... Cergy.

Out of 19 selected species from the Shelly gravel-pit at Swanscombe, 13 are found at Erith, 6 at Menchecourt, and 12 at Cergy. The species common to all four stations are: *Elephas antiquus*, *Elephas primigenius*, and *Bithinia tentaculata*; while those common to Swanscombe, Erith, and Cergy, would increase this list by *Planorbis spirorbis*, *Valvata piscinalis*, *Corbicula fluminalis*, and *Pisidium amnicum*.

The fauna of *Elephas antiquus* is characteristic of eolithic horizons; that of *Elephas primigenius* is preëminently paleolithic in its associations. *Bithinia tentaculata* and *Corbicula fluminalis* have a wider range in point of time.

As regards the industrial remains, Mrs Stopes mentions implements of the Acheulian and Chellean types; also discs, fling-stones, scrapers, spoke-shaves, punches, etc., many of them with eolithic facies.

Among the weapons of this transition epoch may be mentioned

<sup>1</sup> Probably the same species.

the *casse-têtes* formed of flint nodules, the natural shapes of which lent themselves readily to such uses. The specimen from Bray illustrated in plate XXIX, B, is an example of this class. The only breaks in the crust of the club-like flint nodule are the two on the side and extremity of the club-end, respectively. At both these places blunt edges have been produced by approximately direct blows. The implement was held like a club to produce the chipping at the side ; and like a pestle to produce that at the extremity.

It was my good fortune to spend eleven days with Rutot during the latter part of July, 1903. Our time was divided equally between Rutot's collections in the Royal Museum of Natural History and the field. The collection, numbering thousands of specimens, was not yet on exhibition, the handsome and commodious new wing of the Museum where it was to be placed not being finished. The installation, however, in M. Rutot's office was such as to render possible a thorough examination, not only of each piece but also of large groups, for comparative study of the various geological horizons.

The careful coördination of museum- and field-work was everywhere evident. Both had been truthfully reflected in Rutot's numerous publications. The latter were already familiar to me, and my object in visiting Belgium was not so much for verification of a master's work as for guidance by that master. My host's first words were : "*Il faut être guidé,*" and my experiences for the next ten days proved the truth of his assertion.

We first visited Binche, the headquarters of that veteran collector, M. N. Dethise, and in the course of the day walked as far north as Leval. In the railway cut at Ressaix-Trieu there is an instructive section showing Lower Eocene sands with superimposed Mosean, Hesbayan, and Flandrian deposits. The flinty layer at the base of the Mosean yielded Reutelian implements, and that at its summit both Mesvinian and Chellean implements. As may be seen in the section (figure 19), these two implementiferous layers merge into one where the Mosean fails, thus causing a *mélange* of industries.

Near the railway station at Leval, the surface of the fields sloping toward the southwest are covered with flints left exposed

through denudation. Here we found an industry representing the transition from the eolithic to the paleolithic. It is one of those gently sloping surfaces facing the southwest, and thus receiving the full benefit of the prevailing winds and rains. The intercalating beds of clay having been washed away, the surface of the field is covered with what has been aptly called *tapis de silex*, resting on an outcrop of Chalk. Here was found the rude poniard figured in plate xxviii, B, fig. 1. It is a simple nodule of parti-colored flint, with a white crust. One extremity was roughly chipped to a point. Two or three prominences had been removed from the opposite end so as to make it fit the hand comfortably. A single stroke served not only to remove a projection near the base, but also to reduce the circumference at this point, thus tending to

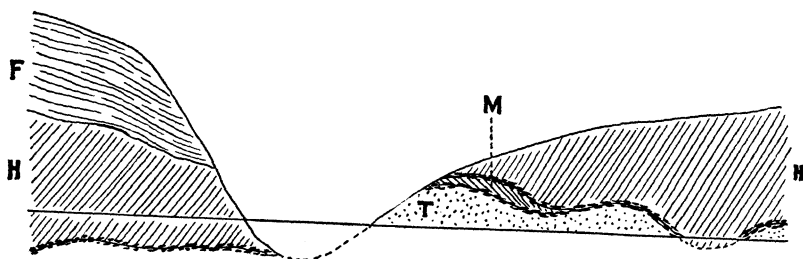


FIG. 19. — Section in the railway cut at Ressaix-Trieu (from a sketch made in the field). *F*, Flandrian (Upper Quaternary). *H*, Hesbayan (Middle Quaternary). *M*, Mosean (Lower Quaternary), with Reutelian implements at its base and Mesvinian and Chelleian implements at its summit. *T*, Lower Eocene.

produce a guard. A sharp edge left by the removal of the flake in question was reduced by means of many slight blows or retouches so as not to cut the hand.

We spent another day at Écaussines-Carières, largely for the purpose of becoming familiarized with the various Quaternary deposits. Perhaps the best section exposed was that in the Thiar-mont quarry (figure 20). It shows how the pockets in the old eroded surface of the Carboniferous limestone are filled with Wealden deposits, over which is spread the Mosean. Above the Mosean come, in turn, the Hesbayan (Loess), the Brabantian, Flandrian, and brick-earth. This section shows the contact of the Brabantian clays on the one hand with the underlying Hesbayan mantle, and on the other, with the superimposed Flandrian deposits. Rutot

believes that the Brabantian (eolian) was not an epoch favorable to human existence, and yet there is some evidence tending to show that the Eburnean races penetrated Belgium at that time.

The most interesting excursion of the series was the one to Harmignies, Spiennes, and the Exploitation Helin, near Spiennes, which were reached by way of Mons. There are interesting sections in two railway cuts between Mons and Harmignies. The one nearest Mons, the Mesvin cut, furnished the first eoliths to be found

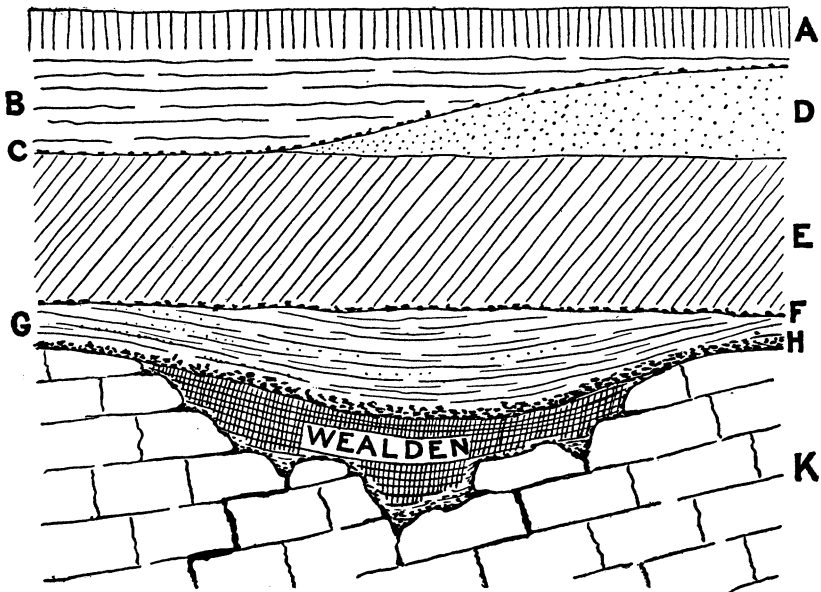


FIG. 20.\*—Section of Thiarmont quarry at Écaussines-Carrières, forming the lower terrace of the Sennette valley (from a sketch made in the field). *A*, Brick-earth. *B*, Stratified sandy clay ("ergeron"), Flandrian. *C*, Thin flinty layer. *D*, Pulverulent, non-stratified clays of eolian origin, Brabantian. *E*, Stratified clay, Hesbayan. *F*, Stony layer. *G*, Fluvial sands, obliquely stratified, with intercalated seams of gravel, Mosean. *H*, Stony layer with fragments of phthanite. *K*, Carboniferous limestone.

in Belgium, and gave its name to the Mesvinian epoch of the eolithic period. In the other may still be seen the pits sunk in neolithic times to obtain the fresh flint used in the manufacture of chipped and polished implements.

From Harmignies we returned on foot along the railway, by special permission. Leaving the railway at the crossing of the

highway which leads in a northwesterly direction to Mons, we soon reached the level of a middle terrace, 25 and more meters above the bed of the Trouille river. It was here that M. É. de Munck discovered recently a spread of eoliths belonging to the Reutelian epoch.

As the surface slopes gently toward the southwest, the upper layers of the terrace have disappeared, leaving the flinty layer at its base exposed. This layer rests on the Chalk, the surface of which was eroded during Mosean times. Between the sand-filled gullies in the Chalk is found the spread of flints, many of them showing unmistakable traces of utilization. The locality is especially noted for polyhedral fling-stones and hammer-stones, the latter bearing evidence of having seen much service.

After being told where to look, my search was rewarded. The first find was a typical Reutelian hammer-stone (plate XXVI, B, fig. 4), characteristic also of that particular locality, since it bore marks of having been much used. It is a flint nodule that had been but slightly altered by chance flaking before being utilized. Only one of the old surfaces of fracture has been preserved. The rest of the exterior either retains the original nodular crust or has been modified by artificial chipping. One end and one margin are thoroughly battered by use. The crest of the battered margin is zigzag in its course, showing how the chips came off, first on one side and then on the other, due to the uncertainty of landing a blow true with a stone whose transverse diameter is less than half that of the diameter in the same plane with the direction of the blow that is dealt. The other end and margin show no evidence of having given or received perpendicular blows. They were adapted to the hand simply by the removal of a few flakes.

I found several other Reutelian implements before we left the terrace above Harmignies. Only two of these are figured (plate XXVI, B, figs. 1 and 2). Figure 2 is a very interesting specimen. It is a natural flake with a little crust left on the outer surface. The inner surface is weathered white and is in rather sharp contrast with the fresher appearing worked margins. The heel and the greater part of one margin are left untouched. The other margin and the point are carefully retouched. For a part of the way the

worked margin is chipped on both sides. Near the base, or heel, a notch has been carefully retouched, on one side only, to form a scraper of the spoke-shave type. Figure 1 is one of the polyhedral fling-stones, which, like the oft-used hammer-stones, are characteristic of the locality in question. It may be recalled that similar stones were found on the Chalk plateau. A Reutelian scraper (fig. 3) from Bois d'Epinois, valley of the Haine, near Binche, the gift of Dr Rutot, is grouped with the Harmignies specimens for convenience. It is a natural flake of flint, quadrangular in shape, the only sharp margin of which, after being dulled by use, has been retouched with a view to further utilization. The Yale Museum is also indebted to Dr Rutot for a valuable series representing the various eolithic horizons as well as the transition to the paleolithic.

Leaving the Reutelian station above Harmignies, we traversed the famous Champs à cayoux and picked up a number of neolithic implements, including nuclei and flakes. These are from the ancient workshops that once covered an area of more than 120 acres. The locality first came into notice in 1840 through the researches of M. Albert Tolliez. Twenty years later Tolliez discovered that the fresh flint nodules, utilized in the manufacture of implements, came from galleries in the Chalk, reached by means of pits sunk through the Quaternary deposits and Tertiary sands. The discovery was confirmed in 1867, when the new railway from Mons to Charleroi, via Harmignies, was cut through the Champs à cayous, laying bare no fewer than twenty-five of these pits.

Finished implements, as well as those in the rough, nuclei and flakes, have found their way from the sites of these ancient workshops to museums in almost every land. The Yale Museum being an exception, and the supply being not yet exhausted, our collecting bags grew perceptibly heavier before we reached the village of Spiennes and turned northward on our way across fields to the Exploitation Helin, in the direction of Saint-Symphorien.

The section at the Exploitation Helin has been already described (figure 18). Having become somewhat familiar with the aspect of the Belgian series of Quaternary deposits by a study of sections in various localities, notably at Ressaix and in the Thiarmon quarry

at Écaussines-carrières, I was able to recognize the superimposed beds in the pits of Helin without much assistance from Dr Rutot.

Of the specimens illustrated in plates xxvii, B, and xxviii, A, some were found by Dr Rutot and some by myself. All are from the flinty layer at the top of the Mosean. The specimens in plate xxvii, B, have been retouched, are slightly weathered, and show marks of wear, in part, no doubt, from use, and in part, it may be, from natural causes. Figure 1 of this plate shows a rather flat, artificial flake with the original greenish crust intact over the outer surface. The margins are carefully worked on both sides of the blunt, beak-like apex. Figure 2 is likewise an artificial flake with prominent bulb of percussion. The two margins that lead to the sharp projection are retouched, but on opposite sides. This reverse working produces a point that might well have been used as a reamer. Figure 3 represents a type of implement common to the eolithic period, but very rare in the paleolithic. It was used to retouch the dulled edges of flint flakes; hence the name *retouchoir* given to it by Rutot. The piece in question is a prismoid flint flake, the thinnest margin of which has been reduced in certain places by use. Figure 4 is an artificial flake that has retained the outer crust. The approximately straight edge is retouched from one side only and along its entire length.

The specimens figured in plate xxviii, A, are all non-utilized pieces. The surfaces of fracture are perfectly fresh, and the edges and corners are neither retouched nor worn. Figures 1-2 are artificial flakes, and figure 3 is a core from which several flakes have been artificially removed.

It is fitting to close with the Exploitation Helin for two reasons: (1) It contains in undisturbed section all the Belgian Quaternary deposits except one, and that one, the Brabantian, is above the eolithic zone; (2) In its superimposed beds have been found implements representing every eolithic epoch with the exception of the Reutelian, at the bottom of the Belgian series. It is, therefore, of itself the best résumé of the eolithic problem, being, as it is, an epitome of the stratigraphic evidence on which the solution of the question depends so largely. To complete the stratigraphic evidence one has only to turn to the lowest beds of the middle ter-

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1



B. 1, Leval (p. 458), 2, Bray, valley of the Haine (p. 454).

2

1

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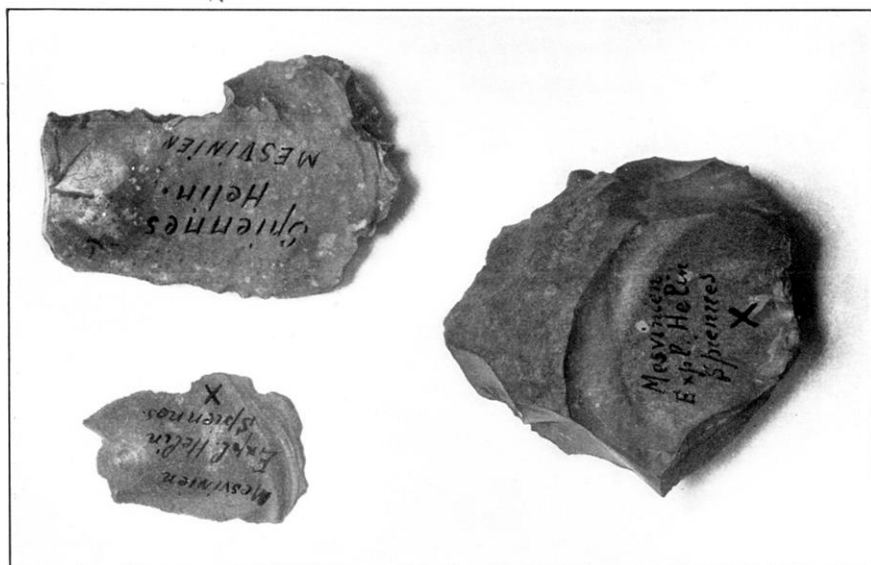


Photo by G. G. MacC.

A. Exploitation Helin, near Spiennes (p. 462).

OLITHS FROM BELGIUM (ABOUT THREE-FIFTHS NATURAL SIZE)

racés in such sections as that near Ypres, valley of the Lys, or at Salzinnes les-Namur, valley of the Sambre.

But stratigraphy alone is of no avail unless the specimens themselves are recognized as artifacts. The arguments in favor of their acceptance as such have been given at length in discussing the plateau specimens from England. If further evidence along this line be required, the reader is referred to Rutot's papers entitled, "Les actions naturelles possibles sont inaptes à produire des effets semblables à la retouche intentionnelle,"<sup>1</sup> and "Sur la cause de l'éclatement naturel du silex."<sup>2</sup> Lack of space renders it impossible to enter here into the details of Rutot's experiments and arguments, proving the inadequacy of the possible, natural, and accidental causes that might be invoked as apt to produce the effect of intentional working. The natural causes are: (1) Change of temperature, (2) torrential action, (3) action of the waves of the sea, and (4) the settling or sinking of the beds in question.

Prestwich had also given this subject much attention. His chief reasons for believing that the plateau specimens could not have been shaped by natural causes were: (1) That they admit of arrangement into definite groups based on form; (2) the parallelism of the flakes struck off is the result of intention and not of accident; (3) many of the forms are suggestive of definite uses as tools and implements; (4) the character of the work is the same for those of which the uses appear obscure. But the advocates of the artificial nature of these specimens are not called on to find a use for every type of implement. We are reminded by Abbott that if the only boomerangs in existence were fossil boomerangs, it would take an expert guesser to hit upon the use to which we happen to know they are put. So certain was Prestwich in his exclusion of natural-cause theories, particularly the effects of wave-action, that he offered the two volumes of his *Geology* for half a dozen shore flints (not derived) of any of the plateau types figured in plates v to ix, of his "Collected Papers on some Controverted Questions of Geology."

Mr W. J. Lewis Abbott, himself an expert judge of precious and semi-precious stones, has experimented much in the working of

<sup>1</sup> *Bull. et mêm. Soc. d'anthr. de Bruxelles*, 1902, xx.

<sup>2</sup> *Ibid.*, 1904, xxiii.

flint, and knows, as well as any one, the limitations imposed on the range of effects produced by natural or accidental causes. One of the implements he found in the *Elephas* deposits of the Cromer beds showed "a well marked *éraiillure*." He has made "thousands of experiments of fixing flints and pitching round pebbles at them, and thus removing flakes." He adds: "By special suspension arrangements, I was able to administer any number of blows at any particular spot with various degrees of force; but I was never able to produce this scar (*éraiillure*) in any way in which it may be conceived Nature worked." Another set of experiments included the placing of flints, fixed and otherwise, at the bottom of a long, inclined trough and letting stones slide down upon them; but "always with a negative result." On the other hand, when he has "tried to make a clean chop off a mineral," he was always "annoyed by a characteristic kick, giving rise to the *éraiillure*." Abbott explains that when one wishes to deal a blow in a definite direction and in a given spot, the concentration of muscular power to land the blow on "that particular spot, and even to keep the hammer there," occasions a secondary blow, produced by the voluntary muscular opposition to the rebound. The same phenomenon results when one attempts to drive a nail in an awkward place by a series of deliberate blows, each of which will be followed by a second, involuntary tap. It is this tap that removes the small flake from the bulb of percussion and produces the well-known *éraiillure*. This, Abbott considers of more importance than the bulb of percussion itself, and indubitable proof of an intentionally directed blow. The bulb of percussion on one of the non-utilized artificial flakes (plate XXVIII, A, fig. 2) from the Mesvinian level in the Exploitation Helin is marked by a characteristic *éraiillure*.

The recognition of eoliths as artifacts, and the determination of the geological horizons where they are found *in situ*, pave the way to the development of systems of relative chronology and a special terminology. I have referred already to the de Mortillet system (page 426) which provided for an eolithic period. But I have endeavored to show that priority in the use of that term belongs to Mr J. Allen Brown — a fact in the history of the science worthy of emphasis, especially since the credit is generally given to de Mortillet.

Rutot, for example, says:<sup>1</sup> "Le mot servant à caractériser l'idée, si importante, de l'existence de toute une longue série d'industries primitives antérieures au Paléolithique est trouvé depuis longtemps, et c'est G. de Mortillet qui, croyons-nous, l'a proposer le premier, c'est le mot éolithique." Another author has made the same mistake in an important work that appeared only this year. M. A. Doigneau, whose book<sup>2</sup> I reviewed for the *American Anthropologist*,<sup>3</sup> says: "On accepta définitivement le nom de Éolithique (aurore de la pierre) déjà précédemment proposé par G. de Mortillet, pour désigner l'époque qui précéda celle de Chelles et pendant laquelle naquit l'industrie de la pierre." My statement (on page 426) of J. Allen Brown's claims to priority was written before the two works of Rutot and Doigneau, respectively, were published; which is my reason for emphasizing it here.

De Mortillet's provisions for an eolithic period were so meager and uncertain that little except an historical significance attaches to them now. It could hardly have been otherwise. The wonder is that he built so well, working almost wholly in the dark and against the dominant views of his time.

Rutot profited both by the successes and the failures of his forerunner. His system, which covers all the periods of the stone age, is reproduced in extenso. Attention is directed particularly to the part dealing with the eolithic period, which is preëminently his own and which was built up gradually in the light of long and painstaking investigations. I have added the Dewlish industry to his classification, associating it with that of the Cromer Forest-bed and Saint-Prest. Archibald Geikie<sup>4</sup> is my authority for placing the Dewlish gravels with the Cromer Forest-bed group. Both are referred to the same horizon in the Upper Pliocene, and both are estuarine and fresh-water deposits. Thus the synchronism between the industrial remains found by Abbott near East Runton, Norfolk, and those taken by Dr Blackmore from the Dewlish gravels, in Dorset, is established.

<sup>1</sup> Le préhistorique dans l'Europe centrale. Extrait du *C.-R. du Congr. d'archéol. et d'hist.*, Dinant, 1903, p. 244.

<sup>2</sup> *Nos ancêtres primitifs*, Paris, 1905, p. 36.

<sup>3</sup> Vol. VII, 1905, p. 120.

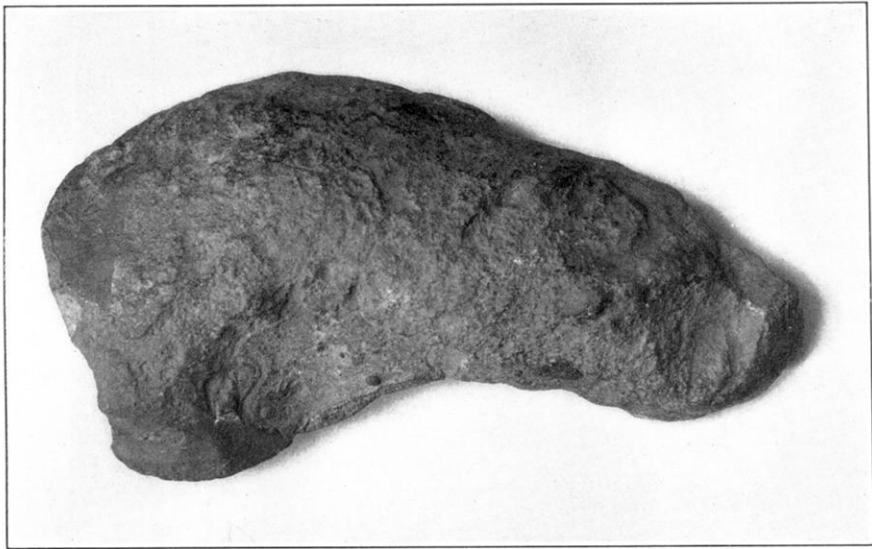
<sup>4</sup> *Text-book of Geology*, 4th ed., 1903, p. 1281.





*Photo by G. G. MacC.*

A. 1, Milton Street, Kent (p. 455). 2, Shelly gravel-pit, Swanscombe Kent (p. 455).



B. Bray, valley of the Haine, Belgium (p. 457).

EOLITHS FROM ENGLAND AND BELGIUM (ABOUT THREE-FIFTHS NATURAL SIZE)

Rutot has more recently attempted to adapt a time-scale, based on the measure of the advance and retreat of glaciers, to his system of epochs. The values of that portion dealing with the divisions of the eolithic period are as follows :

Reutelian epoch	25,000 years.
Mafflean “	12,500 “
Mesvinian “	12,500 “
Strépyan “ (transition)	5,000 “
Paleolithic period	84,000 “

The above estimate would give 139,000 years as the duration of the Quaternary, a figure not considered excessive in the light of various estimates placed on the duration of the earlier geologic periods.

#### CONCLUSIONS

A study of the Rutot classification renders needless anything more than the briefest summary. We have endeavored to give the problem a setting such as would bring into relief its nature and import. While in reality the first of the stone-age periods, the eolithic is the last to receive recognition.

To be readily acceptable, an idea must not run counter to prejudice. It must be stated with clearness and authority and at the right time. The right time does not mean after there is no longer prejudice. It means rather the moment that the originator of the idea is able to find one, or, better, several advocates who can speak with an authority equal to his own. In Law the truth is not established by the mouth of one witness only. Similar safeguards should protect a growing science.

The idea of a primitive industry antedating the Chellean was proclaimed not only at a time when it ran counter to prejudice, but also before it could be stated with clearness and authority. The importance of the Abbé Bourgeois's discoveries at Thenay in 1867 are still open to question ; but the measure of his prophetic vision finds abundant expression in present-day fulfilment. Bourgeois supposed that he had found artifacts in the Oligocene. He may have been mistaken. It did not matter much, so long as his attempt inspired further effort. Rames came along later and did find artifacts in the Upper Miocene at Puy-Courny. Before Rames

made known his discovery, Harrison had begun to find worked flints on the North Downs of Kent; so that the time to speak the word of authority was to come with Rutot's lucid presentation of the combined evidence, based on stratigraphy, paleontology, and technology.

The importance, then, of verification cannot be too strongly emphasized. But there are two kinds of verification: that which is done by a third party and that which one does himself. Personal verification is, naturally, the most convincing. To make this supreme test before passing judgment on so important a question, I spent considerable time both in Belgium and in the South of England.

The question does not admit of profitable study in any other way. My opinion, based on personal experience, is given simply as such. It is that the existence of a primitive industry, antedating what is commonly accepted as paleolithic, has been established. This industry occurs as far back as the Upper Miocene and continues on through the Upper Tertiary into, and including, the Lower Quaternary. The distinguishing characters of the industry remain but little changed throughout the entire period, the subdivision of the period into epochs being based on stratigraphy and not on industrial characters. The requirements in the way of tools being very simple and the supply of material in the way of natural flakes and fragments of flint being very plentiful, the inventive powers of the population remained dormant for ages. Hammer and knife were the original tools. Both were picked up ready-made. A sharp-edged, natural flake served for one, and a nodule or fragment served for the other. When the edge of the flake became dulled by use, the piece was either thrown away or the edge was retouched for further use. If hammer or flake did not admit of being held comfortably in the hand, the troublesome points or edges were removed or reduced by chipping. The stock of tools increased slowly with the slowly growing needs. As these multiplied, and the natural supply of raw material diminished, the latter was supplemented by the manufacture of artificial flakes. When the lesson of associating definite forms of implements with definite uses was learned, special types arose, notably the amygdaloid implement and

the poniard. Then came the transition from the eolithic to the paleolithic, a stage that has been so thoroughly investigated by Rutot.

Finally, in the preparation of this paper, I was enabled to settle a question of priority by discovering that it was J. Allen Brown, and not Gabriel de Mortillet, who first proposed the name "eolithic."

The appended bibliography is far more complete than any other that has been prepared on this subject, the number of listed papers and references reaching a total of 154. The only other serious attempt at a bibliography was made by the Rev. R. Ashington Bullen in 1903, and includes 51 titles.

Argument, evidence, demonstration, are mental stimuli, the potency of which varies with the individual. That which serves to convince one, may not have the slightest effect on another. If the credulous are over-sensitive, the incredulous are certainly the opposite. In neither case is the argument necessarily at fault.

To the minds incredulous on the subject of the reality of an eolithic industry, my advice is: Do as Capitan, Klaatsch, Schweinfurth, and others, including myself, have done. Examine the Rutot series in Brussels, methodically collected and classified. Listen to Rutot's own story supplemented by demonstration with specimens; then go with him to the field. No one could be more patient, more obliging, more helpful. But you would probably lose sight of these traits, momentarily at least, through the pervasive enthusiasm of their possessor and the force and logic of the demonstration. One day in the field may suffice. It may require several. If not convinced finally, you will be the first exception to the rule.

The subject, however, is not so simple as might be supposed. Even exhaustive series of specimens, systematically arranged and carefully labeled, are cold, dry, and lifeless until a living soul breathes into them the breath of life. Rutot sent a very instructive series to the Louisiana Purchase Exposition at St Louis.<sup>1</sup> Unfortunately he was not there to interpret them. What impression they made, even on those accustomed to study stone artifacts, remains to be seen. It is a pleasure to be able to record that, at the

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<sup>1</sup> A grand prize has been awarded to the Brussels Museum of Natural History for the Rutot series. (See *Amer. Anthropologist*, 1905, VII, 161, "Classified Relics.")

close of the Exposition, the collection was sent as a gift to Prof. F. W. Putnam of the Peabody Museum, Harvard University.

Only the other day a professor of anthropology in one of our leading eastern universities asked me if I was acquainted with Rutot's publications on the eolithic question. When answered in the affirmative, he further inquired, "Can you make anything out of them? I can't." I had to confess that they puzzled me also at first; but that having found the key, every difficulty had suddenly disappeared. "And the key?" "The key is Rutot himself and his environment," was my answer. "Know him, cover with him some, at least, of the ground that he has covered, and the language he speaks will no longer sound strange and unfamiliar."

It is well and even natural that archeologists should become absorbed in local problems. That is, in fact, why Rutot has succeeded in accomplishing so much. It is also well that workers in one part of the world should know and appreciate what is being done in other parts. It takes more than weavers to make a garment. There are also cutters and fitters. A like division of labor obtains among the prehistoric archeologists who should know the figure that must be clothed before they attempt to cut a garment that will fit.

If in the writing of this paper even one of several results is accomplished, I shall feel justified in the attempt, and well repaid for the labor expended. While introducing to Americans certain European authorities, it may also serve the rôle of interpreter, and lead to a better understanding and appreciation of what is being done on the other side of the Atlantic. Again, it may incite some to follow the advice given above and to investigate for themselves a problem the correct solution of which cannot fail to add materially to our knowledge of humankind.

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